

## CLAIMS

1. A battery system that estimates a state of charge of a battery, comprising:
  - a meter that generates a terminal voltage signal of said battery and a terminal current signal of said battery; and
- 5 a controller that employs a linearized model of said battery and a time-varying state estimator to process a synthesized input based on said terminal current and said terminal voltage to estimate said battery state of charge.
2. The battery system of claim 1 further comprising a generator that is controlled by said controller to selectively charge said battery based on said state of charge.
3. The battery system of claim 1 wherein said controller predicts a current state of charge based on a prior state of charge, predicts a current state of charge error based on a prior state of charge error, determines a current gain based on said current state of charge error and updates said current state of charge based on said prior state of charge.
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4. The battery system of claim 1 wherein said synthesized input compensates for gassing and self-discharging of said battery.
5. The battery system of claim 1 wherein said synthesized input compensates for dynamic impedances and non-linear characteristics of said battery.
6. The battery system of claim 1 wherein said battery is a lead-acid battery.

7. A method of estimating a state of charge of a battery, comprising:

modeling said battery with a linear equation;

measuring a terminal current of said battery;

5 measuring a terminal voltage of said battery; and

processing said linear equation through a time-varying state estimator based on said terminal current and said terminal voltage to determine said state of charge.

8. The method of claim 7 wherein said linear equation is a process model that models changes in said state of charge based on current.

9. The method of claim 7 further comprising determining a synthesized input wherein said processing is further based on said synthesized input.

10. The method of claim 7 wherein said step of processing said linear equation comprises:

predicting a current state of charge based on a prior state of charge;

5 predicting a current state of charge error based on a prior state of charge error;

determining a current gain based on said current state of charge error; and

10 updating said current state of charge based on said prior state of charge to provide said state of charge of said battery.

11. The method of claim 10 wherein said state of charge error is continuously updated.

12. The method of claim 7 wherein said battery is a lead-acid battery.

13. A method of estimating a state of charge of a battery, comprising:

modeling said battery based on a linear process equation; determining a synthesized input based on a terminal current

5 of said battery and a terminal voltage of said battery; and processing a time-varying filter based on said process equation and said synthesized input.

14. The method of claim 13 wherein said step of processing a time-varying filter comprises:

predicting a current state of charge based on a prior state of charge;

5 predict a current state of charge error based on a prior state of charge error;

determining a current gain based on said current state of charge error; and

10 updating said current state of charge based on said prior state of charge to provide said state of charge of said battery.

15. The method of claim 14 further comprising determining an initial value of said state of charge wherein said initial value is used as said prior state of charge to initially predict said current state of charge.

16. The method of claim 13 wherein said synthesized input compensates for gassing and self-discharging of said battery.

17. The method of claim 13 wherein said synthesized input compensates for dynamic impedances and non-linear characteristics of said battery.

18. The method of claim 13 further comprising modeling non-linear dynamic voltage characteristics of said battery wherein said step of processing is further based on said dynamic voltage characteristics.

19. The method of claim 13 wherein said battery is a lead-acid battery.